COMMONWEALTH OF KENTUCKY
BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of:

MATRIX ENERGY, LLC FOR DETERMINATION OF RETAIL ELECTRIC SUPPLIER	)))	CASE NO. 2003-00228

MATRIX ENERGY, LLC ANSWERS TO COMMISSION STAFF'S FIRST DATA REQUEST TO MATRIX ENERGY, LLC

Comes Matrix Energy, LLC, by counsel, and for its Answers to the First Data Requests submitted by the Commission staff to Matrix Energy, LLC, states as follows:

1. Refer to pages 5 and 6 and Exhibit C of the Testimony of Paul Horn ("Horn Testimony"). Matrix states that Big Sandy Rural Electric Cooperative Corporation ("Big Sandy") agreed to allow Kentucky Power Company d/b/a American Electric Power ("Kentucky Power") to temporarily supply power during construction performed by Matrix in Big Sandy's service territory. Is the time period for temporary service unlimited? If no, when does the agreement for temporary service expire?

Answer: During the January 2002, meeting between the representatives of Big Sandy RECC ("Big Sandy"), East Kentucky Power ("EKP") and Matrix, Big Sandy was advised that the mine entrance was to be constructed on Czar's property and electric service needed to be provided to this mine entrance by April of 2002. At that time, Big Sandy's representatives indicated that it would take approximately one year for Big Sandy to provide electric service to the mine entrance and indicated that temporary power could be obtained from the Czar

distribution system, which was being served by AEP, to start the development of the slope entrance and ventilation shaft to the mine, which would take approximately one year. Because Big Sandy stated that it would take approximately one year for it to build the infrastructure necessary to provide electricity to the mine, it was understood that authorization had been provided to obtain temporary electric service from AEP for approximately one year, or until Big Sandy built the infrastructure necessary to serve the mine.

2. Matrix states that the letter attached as Exhibit C, which refers to a new 2,000 KVA substation for Beech Fork Mining located at the Sycamore Fork of Daniel's Creek, is believed to be Big Sandy's authorization for Beech Fork Mining to obtain power from Kentucky Power to build the entrance to the Matrix mine.

a. Provide the location of the substation in reference to the mine entrance referred to in the complaint.

b. Are there any other 2,000 KVA substations for Beech Fork Mining located in Big Sandy's territory? If yes, provide the number and location.

Answer: (a) The location of the substation in reference to the Matrix mine entrance is reflected on the map identified as Exhibit E.

(b) Yes. There are three 2000 KVA substations for Beech Fork mining operations located in Big Sandy's territory. One is the substation owned by Beech Fork referred to in question 2(a), which serves Beech Fork's Taurus No. 9 deep mine. Kentucky Power provides the power to this substation from the Czar distribution system. A second 2000 KVA substation owned by Beech Fork serves Beech Fork's No. 6 mine. Big Sandy provides the power for this substation. Beech Fork owns one 2000 KVA substation at its coal preparation plant. Big Sandy

provides the power to this substation.

3. Refer to pages 9 and 12 of the Horn Testimony. Matrix states that Big Sandy never provided Matrix with its rates.

a. Provide the source of information used to determine the cost differential on pages 9 and 10.

b. Did Big Sandy and Matrix ever discuss developing a special rate that would be comparable to the rate available from Kentucky Power?

c. Has Beech Fork Mining or any of its affiliates been offered a 15-year contract for electric service to the Matrix project? If no, explain the basis and validity of the 15-year present worth electric rate comparison.

d. Has Matrix evaluated the interruptible electric rates that might be offered by either electric service provider?

e. Has Matrix evaluated the possible reductions in rates from either electric service provider if Matrix owns its own substation and distribution facilities?

Answer: (a) The source of the information used to determine the cost differential was the Public Service Commission Web Site.

(b) No.

(c) Beech Fork and its affiliates have not been offered a 15 year contract for electric service to the Matrix mine. The basis for the 15 year term used in the cost comparison is the projected life of the Matrix mine.

(d) No. Matrix is unfamiliar with the term "interruptible service". Matrix requires a consistent power supply to its mine for the safe and efficient operation of the mine.

(e) Yes. A number of the affiliates of Matrix own their own substations and distribution facilities, such as the substation and distribution facilities on the Czar mine site, which are owned by Czar.

4. Explain the extent to which Matrix has considered building or requesting a 138/35.4 kV or 138/12.47 kV substation adjacent to the Kentucky Power 138 kV transmission line due to the close proximity to the mine mouth.

Answer: Matrix evaluated the cost savings per month of requesting a 35.4 kV or 12.47 kV substation adjacent to the Kentucky Power 138 kV transmission line, but the cost savings were minimal and did not justify the cost to construct a tap to the 138 kV line, the necessary substation and associated power lines. Furthermore, the personnel of Matrix and its affiliated companies do not have any experience in working with a 138 kV line. They have substantial experience in working on 69kV and smaller power lines.

5. Explain any objections that Matrix would have to one retail electric supplier owning a substation with distribution circuits sub-metered to another retail electric supplier feeding its defined load.

Answer: If only one utility provides power to the Matrix mine, during a blackout or brownout condition, Matrix will know to contact only one electric company to discover the reason for the condition. This should expedite the resolution of the problem causing the blackout or brownout condition. Additionally, a single service provider to the mine is an important safety factor because when power to the mine fails, there will not be a question about whether lines to certain equipment are energized. This is a very serious concern because an individual working in the mine could mistakenly think the entire mine is without electricity and come into contact with

an energized line. Furthermore, Matrix objects to paying a pass through rate resulting from the involvement of more than one service provider. However, even if no pass through rate is applied, the safety concerns still exist.

6. In reference to the Horn Testimony:

a. What is the boundary of the property known as the Czar mining site as noted in Question 12?

b. Provide the source for the answer to Question 12.

c. Provide all engineering calculations and support data used to determine the estimated 10 percent loss in power over the 1.6 miles of distribution line as noted in the answer to Question 18.

d. Is the 10 percent loss noted in the answer to Question 18 a loss (drop) of voltage level or a loss of energy?

e. Has the installation of regulators and/or capacitors been considered to reduce the loss of energy as well as the drop in voltage over the distribution line?

Answer: a. See the map identified as Exhibit D.

b. The lease whereby Czar has the right to mine the Czar Mine, and Paul Horn's familiarity with the Czar mine site.

c. Assuming that Big Sandy would be running a 13,200 volts over 1.6 miles, the estimated 10 percent loss in power over the 1.6 miles of distribution line is based upon the 24 years experience of Ted McGinnis, Vice President of Matrix, operating mines from various power sources, as well as the information contained in Information Circular 9258 Titled Mine Power Systems published by the United States Department of the Interior.

d. The ten percent loss noted in the Answer to Question 18 is a drop in voltage levels which equates to a loss of energy.

e. Yes. Capacitors and regulators have been installed in other mines owned by the affiliates of Matrix, but a loss of power is still experienced. Due to the power extremes experienced in mining operations, capacitors and regulators cannot react quickly enough in the event of a sag or reduction in power.

7. Provide the reasoning used to determine the distribution voltage requested, either 12.47 kV or 35.4 kV.

Answer: Due to the unusually high power demands of electric equipment used in the mining industry, Matrix requires the distribution voltage of 34.5 kV at the mouth of the mine in order to minimize the loss of power inside the mine and therefore minimize any damage to its electric mining equipment. For example, Matrix will utilize two electric motors on the conveyor belt at the mouth of the slope mine which have a combined demand of 1,500 horsepower. If these motors are out of service for any reason, the mining operations will cease. Matrix wishes to maintain sufficient power at the downstream end of the lines in the mine. Furthermore, 34.5 kV is utilized in the operation of several of the mines operated by Matrix' affiliates.

8. Provide a copy of all contracts for either firm power or temporary power between Beech Fork Mining, its affiliates, and any retail electric supplier.

Answer: See the documents provided at Tab 1.

9. Provide the supply voltage tolerances for all major items of equipment and the source of said information.

Answer: The supply voltage tolerances for Matrix equipment are contained in the documents provided at Tab 2.

10. Provide all calculations and data pertinent to the sizing of the substation requested by Matrix.

a. Was the electric load of Matrix ever estimated to a retail electric supplier as being greater than 3,000 kW?

b. If yes, what was the load estimated to be, when was the estimate made, and to which retail electric supplier was it presented?

Answer: a. Yes.

b. The estimated load of 3344 volts was presented to the representatives of Big Sandy at the meeting held at its offices in January of 2002. This information was also provided to Greg McKinney with EKP in an email dated February 25, 2002. (See the document provided at Tab 3.)

11. Does Matrix have a contract for temporary service with Kentucky Power? If yes, provide a copy of the contract.

Answer: Matrix does not have a contract for temporary service with Kentucky Power. However, Czar has a contract for service with Kentucky Power, and a Czar line was extended to the entrance of the Matrix mine to supply temporary power for the construction of the slope and shaft of the Matrix mine.

12. What consideration, if any, was given by Matrix to tap Kentucky Power's 138 kV line crossing the Matrix/Czar property, rather than the 69 kV line? Provide any cost estimates for this alternative.

Answer: Matrix considered tapping Kentucky Power's 138kV line crossing the Czar

property. However, the cost savings realized using the 138kV line were substantially less than the cost savings realized from tapping the 69 kV line. The information set forth at Tab 4 reflects that the projected cost per month of power from the 69kV line was $41,119.57 and the projected cost per month of power from the 138kV line was $39,696.84. However, taking into consideration the cost to construct the substation tapping into the 138kV line and the cost of other equipment and lines, the cost of tapping into the 69kV line was substantially less. Furthermore, Matrix and its affiliates have personnel experience in working with 69kV lines, and it would have to employ additional personnel in order to work on the 138kV line. See the documents provided at Tab 4.

13. Where are the proposed metering points (i.e., points of delivery) in the following scenarios:

a. A new substation is built by either Kentucky Power or East Kentucky Power Cooperative, Inc.

b. A customer-owned line is built and/or extended.

c. Big Sandy/Kentucky Power lines are built and/or extended.

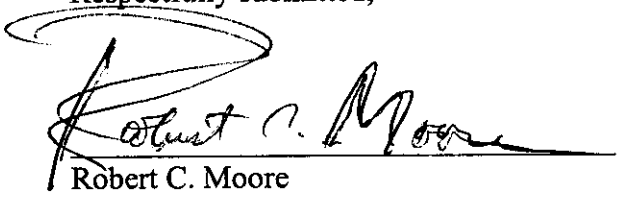
Answer: Under all three scenarios, the proposed metering points would be determined by the utility. However, Matrix proposes to use the substation adjacent to the 69kV line as the proposed metering point under any of the scenarios.

14. For each existing or former mine operated by Matrix or Czar along the boundary between Martin County and Johnson County, provide the name of the mining operation and its retail electric supplier.

Answer: Matrix and/or Czar have not conducted, and do not currently conduct, a mining

operation on the boundary between Martin County and Johnson County. However, companies conducting mining operations on the Czar mining site have obtained power from Kentucky power, with the exception of the mining of part of the Coalburg seam located on the Czar mining site.

Respectfully submitted,



Robert C. Moore
HAZELRIGG & COX, LLP
415 West Main Street
P.O. Box 676
Frankfort, KY 40602-0676
Telephone: (502) 227-2271

COUNSEL FOR MATRIX ENERGY, LLC

CERTIFICATE OF SERVICE

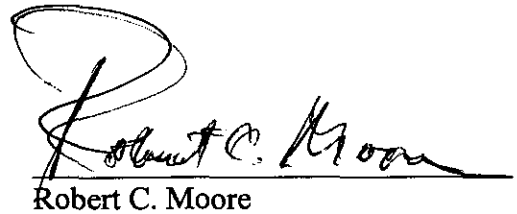
I hereby certify that a copy of the foregoing Answer was served by United States First Class Mail, postage prepaid, on this 17th day of October, 2003 upon:

Rebecca S. Gohmann
Matrix Energy, LLC
107 Dennis Drive
Lexington, Kentucky 40503

Albert A. Burchett
P.O. Box 0346
Prestonsburg, Kentucky 41653

J. Scott Preston
308 Main Street
Paintsville, Kentucky 41240

Mark R. Overstreet
STITES & HARBISON PLLC
421 West Main Street
P.O. Box 634
Frankfort, Kentucky 40602-0634
[By Hand Delivery]



Robert C. Moore

TAB 1

This Contract, entered into this 19th day of June 2001, by and between Kentucky Power Company dba American Electric Power, hereafter called the Company, and Beech Fork Processing, Inc., PO Box 190, Lovely, KY, 41231-0190, or his or its heirs, successors or assigns, hereafter called the Customer.

Witnesseth:

For and in consideration of the mutual covenants and agreements hereinafter contained, the parties hereto agree with each other as follows:

The Company agrees to furnish to the Customer, during the term of this Contract, and the Customer agrees to take from the Company, subject to Company's standard Terms and Conditions of Service as regularly filed with the Public Service Commission of Kentucky, all the electric energy of the character specified herein that shall be purchased by the Customer in the premises located at Middle Fork, Martin County, Davella, KY.

The Company is to furnish and the Customer is to take electric energy under the terms of this Contract for an initial period of 1 month(s) from the time such service is commenced, and continuing thereafter until terminated upon 1 months' written notice given by either party of its intention to terminate the Contract. The date that service shall be deemed to have commenced under this Contract shall be August 1, 2001.

The electric energy delivered hereunder shall be alternating current at approximately 12900/34500 volts, 4-wire, 3-phase, and it shall be delivered Customer's Service Pole from Company Pole # 837-B-73, which shall constitute the point of delivery under this Contract. The said electric energy shall be delivered at reasonably close maintenance to constant potential and frequency, and it shall be measured by a meter or meters owned and installed by the Company and located Company Pole # 837-B-73.

The Customer acknowledges that the Customer may be eligible to receive service under more than one of the Company's schedules and that such options have been explained to the Customer. The Customer and Company agree that the Customer has chosen to receive service under the provisions of the Company's Tariff TS Quantity Power - Subtransmission, code 352. The Customer agrees to pay the Company monthly for electric energy delivered hereunder at the rates and under the provisions of the Company's Tariff TS Quantity Power - Subtransmission, code 359, as regularly filed with the Public Service Commission of Kentucky, as long as that schedule is in effect. In the event that the tariff chosen by the Customer is replaced by a new or revised tariff incorporating different rates or provisions, or both, the Company and Customer understand and agree that the Company will continue to provide service, and the Customer will continue to take service, under this Contract, subject to such changed provisions, and that the Customer will pay for such service at the new rates on and after the date such rates become effective.

The Customer's contract capacity under the tariff named herein is hereby fixed at 2,100kW. If a time-of-day demand is available under the tariff and is selected by the Customer, the reservation of capacity aforementioned shall be the peak period reservation of capacity and shall determine the tariff's minimum monthly billing demand.

There are no unwritten understandings or agreements relating to the service hereinabove provided. This Contract cancels and supersedes all previous agreements, relating to the purchase by Customer and sale by Company of electric energy at Customer's premises as referred to above, on the date that service under this Contract commences. This Contract shall be in full force and effect when signed by the authorized representatives of the parties hereto.

Kentucky Power Company	Beech Fork Processing, Inc.
By: Al Bragg	By: Ed Mahaffey
Alan D. Bragg	
Title: Manager	Title: VICE PRESIDENT
Date: 8/21/01	Date: 7/18/01

Acct # 037-597-104-0

Supercedes contract effective 10-27-98, CIP-TOD, 11,000 KW

This Agreement entered into this twenty-second day of August, 2000 by and between the KENTUCKY POWER COMPANY d/b/a AMERICAN ELECTRIC POWER, hereafter called the Company, and Czar Coal Corporation, H C 64 Box 840, Debord, KY 41214 or his or its heirs, successors or assigns, hereafter called the Customer,

Witnesseth:

For and in consideration of the mutual covenants and agreements hereinafter contained, the parties hereto agree with each other as follows:

The Company agrees to furnish to the Customer, during the term of this Agreement, and the Customer agrees to take from the Company, subject to Company's standard Terms and Conditions of Service as regularly filed with the Public Service Commission of Kentucky, all the electric energy of the character specified herein that shall be purchased by the Customer in the premises located at Inez, at Customer; Peyler Mine Complex on Middle Fork, Martin Co.

The Company is to furnish and the Customer is to take electric energy under the terms of this Agreement for a period of 30 Days from the time such service is commenced, and thereafter until either party shall give the other not less than 30 Days notice in writing of his or its election to discontinue the service. The date that service shall be deemed to have commenced under this Agreement shall be October 25, 2000.

The electric energy delivered hereunder shall be alternating current at approximately 69000, 3 wire, three phase,

and it shall be delivered From Company Metering Structure In Peyler Station

which shall constitute the point of delivery under this Agreement. The said electric energy shall be delivered at reasonably close maintenance to constant potential and frequency and it shall be measured by a meter or meters owned and installed by the Company and located In Company Metering Structure

The reservation of capacity contracted for by Customer under the tariff named herein is hereby fixed at 8,800 KW.

The Customer hereby agrees to pay the Company monthly for electric energy delivered hereunder at the rate and under the provisions of Company's Tariff TS-CIP-TOD, as regularly filed with the Public Service Commission of Kentucky, said schedule being selected by the Customer, as long as said tariff is in effect; and in the event said tariff is replaced by a new or revised schedule incorporating higher or lower rates than those stipulated in the aforementioned tariff, the Company will continue to furnish service as stipulated in the Agreement and the Customer will pay for such service at the higher or lower rates from and after the date when such rates are made effective.

There are no unwritten understandings or agreements relating to the service hereinabove provided.

This Agreement cancels and supersedes all previous agreements relating to the purchase by Customer and sale by Company of electric energy at Customer's premises as referred to above.

This Agreement shall be in full force and effect when signed by the authorized representatives of the parties hereto.

KENTUCKY POWER COMPANY
d/b/a AMERICAN ELECTRIC POWER

By C L Bra

Title Manager - Customer Services

Czar Coal Corporation

By Billy R. Cantrell

Title President

New Account # 039-980-027-0

This Contract, entered into this 31st day of December 2002, by and between Appalachian Power Company dba American Electric Power, hereafter called the Company, and Argus Energy WV, LLC, PO Box 416, Kenova, WV, 25530-0416, or his or its heirs, successors or assigns, hereafter called the Customer.

Witnesseth:

For and in consideration of the mutual covenants and agreements hereinafter contained, the parties hereto agree with each other as follows:

The Company agrees to furnish to the Customer, during the term of this Contract, and the Customer agrees to take from the Company, subject to Company's standard Terms and Conditions of Service as regularly filed with the Public Service Commission of West Virginia, all the electric energy of the character specified herein that shall be purchased by the Customer in the premises located at Customer's Coal Loading Facility on Route 52, Between Dogs Creek Rd and Whites Creek Rd, Kenova, WV.

The Company is to furnish and the Customer is to take electric energy under the terms of this Contract for an initial period of 12 month(s) from the time such service is commenced, and continuing thereafter until terminated upon 6 months' written notice given by either party of its intention to terminate the Contract. The date that service shall be deemed to have commenced under this Contract shall be December 31, 2002.

The electric energy delivered hereunder shall be alternating current at approximately 7200/12470 volts, 4-wire, 3-phase, and it shall be delivered to the Customer's 12 kV Line Attachments to Company's Primary Metering Pole # 388302158000018, which shall constitute the point of delivery under this Contract. The said electric energy shall be delivered at reasonably close maintenance to constant potential and frequency, and it shall be measured by a meter or meters owned and installed by the Company and located on Company Pole # 388302158000018.

The Customer acknowledges that the Customer may be eligible to receive service under more than one of the Company's schedules and that such options have been explained to the Customer. The Customer and Company agree that the Customer has chosen to receive service under the provisions of the Company's Schedule MEDIUM GENERAL SERVICE - PRIMARY, code 217. The Customer agrees to pay the Company monthly for electric energy delivered hereunder at the rates and under the provisions of the Company's Schedule MEDIUM GENERAL SERVICE - PRIMARY, code 217, as regularly filed with the Public Service Commission of West Virginia, as long as that schedule is in effect. In the event that the schedule chosen by the Customer is replaced by a new or revised schedule incorporating different rates or provisions, or both, the Company and Customer understand and agree that the Company will continue to provide service, and the Customer will continue to take service, under this Contract, subject to such changed provisions, and that the Customer will pay for such service at the new rates on and after the date such rates become effective. The minimum monthly charge hereunder shall be as provided in said tariff but not less than $798.85.

The Customer's contract capacity under the schedule named herein is hereby fixed at 550kW. If a time-of-day demand is available under the schedule and is selected by the Customer, the reservation of capacity aforementioned shall be the peak period reservation of capacity and shall determine the schedule's minimum monthly billing demand.

There are no unwritten understandings or agreements relating to the service hereinabove provided. This Contract cancels and supersedes all previous agreements, relating to the purchase by Customer and sale by Company of electric energy at Customer's premises as referred to above, on the date that service under this Contract commences. This Contract shall be in full force and effect when signed by the authorized representatives of the parties hereto.

Appalachian Power Company

By: A L Bragg

Alan Bragg

Title: Manager

Date: 1/21/03

Account Number: 025-467-738-2

Argus Energy WV, LLC

By: T. L. McKenzie

Title: MEMBER

Date: 1/9/03

This Contract, entered into this 31st day of December 2002, by and between Appalachian Power Company dba American Electric Power, hereafter called the Company, and Argus Energy WV, LLC, P.O. BOX 416, KENOVA, WV, 25530-0416, or his or its heirs, successors or assigns, hereafter called the Customer.

Witnesseth:

For and in consideration of the mutual covenants and agreements hereinafter contained, the parties hereto agree with each other as follows:

The Company agrees to furnish to the Customer, during the term of this Contract, and the Customer agrees to take from the Company, subject to Company's standard Terms and Conditions of Service as regularly filed with the Public Service Commission of West Virginia, all the electric energy of the character specified herein that shall be purchased by the Customer in the premises located at Customers mine office and mines on Kiahs Creek, Harts, WV.

The Company is to furnish and the Customer is to take electric energy under the terms of this Contract for an initial period of 12 month(s) from the time such service is commenced, and continuing thereafter until terminated upon 12 months' written notice given by either party of its intention to terminate the Contract. The date that service shall be deemed to have commenced under this Contract shall be December 31, 2002.

The electric energy delivered hereunder shall be alternating current at approximately 19900/34500 volts, 4-wire, 3-phase, and it shall be delivered at the load side deadends of AEP's pole # 559-A-61, which shall constitute the point of delivery under this Contract. The said electric energy shall be delivered at reasonably close maintenance to constant potential and frequency, and it shall be measured by a meter or meters owned and installed by the Company and located on Company's Primary Metering Pole # 559-A-61 on Kiah's Creek, Wayne County, WV..

The Customer acknowledges that the Customer may be eligible to receive service under more than one of the Company's schedules and that such options have been explained to the Customer. The Customer and Company agree that the Customer has chosen to receive service under the provisions of the Company's Schedule LARGE CAPACITY POWER - PRIMARY, code 387. The Customer agrees to pay the Company monthly for electric energy delivered hereunder at the rates and under the provisions of the Company's Schedule LARGE CAPACITY POWER - PRIMARY, code 387, as regularly filed with the Public Service Commission of West Virginia, as long as that schedule is in effect. In the event that the schedule chosen by the Customer is replaced by a new or revised schedule incorporating different rates or provisions, or both, the Company and Customer understand and agree that the Company will continue to provide service, and the Customer will continue to take service, under this Contract, subject to such changed provisions, and that the Customer will pay for such service at the new rates on and after the date such rates become effective. The minimum monthly charge hereunder shall be as provided in said tariff but not less than $19133.00.

The Customer's contract capacity under the schedule named herein is hereby fixed at 3,500kW. If a time-of-day demand is available under the schedule and is selected by the Customer, the reservation of capacity aforementioned shall be the peak period reservation of capacity and shall determine the schedule's minimum monthly billing demand.

There are no unwritten understandings or agreements relating to the service hereinabove provided. This Contract cancels and supersedes all previous agreements, relating to the purchase by Customer and sale by Company of electric energy at Customer's premises as referred to above, on the date that service under this Contract commences. This Contract shall be in full force and effect when signed by the authorized representatives of the parties hereto.

Appalachian Power Company

By: Al Bruce

Alan Bruce

Title: Manager

Date: 1/21/03

Account Number: 025-876-752-1

Argus Energy WV, LLC

By: Ted McKenzie

Title: MEMBER

Date: 1/9/03

This Contract, entered into this 31st day of December 2002, by and between Appalachian Power Company dba American Electric Power, hereafter called the Company, and Argus Energy WV, LLC, P.O. BOX 416, Kenova, WV, 25530-0416, or his or its heirs, successors or assigns; hereafter called the Customer.

Witnesseth:

For and in consideration of the mutual covenants and agreements hereinafter contained, the parties hereto agree with each other as follows:

The Company agrees to furnish to the Customer, during the term of this Contract, and the Customer agrees to take from the Company, subject to Company's standard Terms and Conditions of Service as regularly filed with the Public Service Commission of West Virginia, all the electric energy of the character specified herein that shall be purchased by the Customer in the premises located at Devils Trace Branch of East Fork of Twelve Pole Creek, Wayne County, WV.

The Company is to furnish and the Customer is to take electric energy under the terms of this Contract for an initial period of 12 month(s) from the time such service is commenced, and continuing thereafter until terminated upon 12 months' written notice given by either party of its intention to terminate the Contract. The date that service shall be deemed to have commenced under this Contract shall be December 31, 2002.

The electric energy delivered hereunder shall be alternating current at approximately 19900/34500 volts, 4-wire, 3-phase, and it shall be delivered the Customer's Attachment to the Company's 34.5kV Primary Metering pole # 534-B-135 located at the mouth of Devils Trace Branch of East Fork of Twelve Pole Creek, Wayne County, WV, which shall constitute the point of delivery under this Contract. The said electric energy shall be delivered at reasonably close maintenance to constant potential and frequency, and it shall be measured by a meter or meters owned and installed by the Company and located on Company Pole # 534-B-135.

The Customer acknowledges that the Customer may be eligible to receive service under more than one of the Company's schedules and that such options have been explained to the Customer. The Customer and Company agree that the Customer has chosen to receive service under the provisions of the Company's Schedule LARGE CAPACITY POWER - PRIMARY, code 387. The Customer agrees to pay the Company monthly for electric energy delivered hereunder at the rates and under the provisions of the Company's Schedule LARGE CAPACITY POWER - PRIMARY, code 387, as regularly filed with the Public Service Commission of West Virginia, as long as that schedule is in effect. In the event that the schedule chosen by the Customer is replaced by a new or revised schedule incorporating different rates or provisions, or both, the Company and Customer understand and agree that the Company will continue to provide service, and the Customer will continue to take service, under this Contract, subject to such changed provisions, and that the Customer will pay for such service at the new rates on and after the date such rates become effective. The minimum monthly charge hereunder shall be as provided in said tariff but not less than $7818.70.

The Customer's contract capacity under the schedule named herein is hereby fixed at 1,440kW. If a time-of-day demand is available under the schedule and is selected by the Customer, the reservation of capacity aforementioned shall be the peak period reservation of capacity and shall determine the schedule's minimum monthly billing demand.

There are no unwritten understandings or agreements relating to the service hereinabove provided. This Contract cancels and supersedes all previous agreements relating to the purchase by Customer and sale by Company of electric energy at Customer's premises as referred to above, on the date that service under this Contract commences. This Contract shall be in full force and effect when signed by the authorized representatives of the parties hereto.

Appalachian Power Company

By: [signature]

Alan Brass

Title: Manager

Date: 1/21/03

Account Number: 027-182-288-2

Argus Energy WV, LLC

By: [signature]

Title: MEMBER

Date: 1/9/03

Information Circular 9258

Mine Power Systems

By Lloyd A. Morley

UNITED STATES DEPARTMENT OF THE INTERIOR
Manuel Lujan, Jr., Secretary

BUREAU OF MINES
T S Ary, Director

current for ampacity selection would be about 520 A. Assuming the machine is operating in good mining condition, and using a load-factor calculation with table 8.12 values,

$$I = \frac{(535)(746)(0.6)}{\sqrt{3}\,(550)(1)(0.6)} = 419 \text{ A.}$$

Continuous miners of this size commonly use unshielded 4/0 trailing cables with 90° C-rated insulation. If the ambient is 20° C, the ICEA ampacity from table 8.7 corrected with table 8.9 data is (287)(1.18) = 339 A. This is considerably below the calculated values of 520 and 431 A. Actual visits to underground mines using continuous miners of the same size (535 hp) showed that the 4/0 cable jackets were not warm to the touch, implying cable-conductor temperatures well below the 90° C limit temperature (*32*). Furthermore, the load-factor calculation is based on data from machine cutting and loading, and since a continuous miner does not cut and load continuously, the current would be biased toward a worst case situation. Including the other machine operations (tramming, idle, etc.) would lower the load factor and the calculated current, probably below the ICEA ampacity. Regardless, the load-factor approach reflects this utilization environment more accurately than the NEC approach. It should be obvious that the effective current demand method would be more precise than either of these approaches.

Intermittent Duty Ratings

A major problem implied in the preceding example is that intermittent, fluctuating, or cyclic current through a cable has a different effect on cable heating than continuous loading. The full-load current or NEC approach for conductor sizing basically assumes continuous loading, but true continuous operation of most mining machinery would be a rare occurrence. Mining is inherently cyclic in nature. The Institute of Electrical and Electronics Engineers (IEEE) (*17*) does publish guidelines for rating electrical equipment under various operating conditions, durations, and time sequences of duty. Even though these terms have been used previously in this text, it is beneficial to define them here:

- *Continuous duty.* Operation at a substantially constant load for an indefinitely long time.
- *Short-time duty.* Operation at a substantially constant load for a short and definite specified time.
- *Intermittent duty.* Operation for alternate intervals of load and no-load as definitely specified.
- *Varying duty.* Operation where the amount of load and the length of time the load is applied are subject to considerable variation.

In an endeavor to overcome the problem of mining duty cycles, the United Kingdom and Australian mining laws permit intermittent-duty ratings for mining trailing cables (*9, 37*). These ratings for several popular cable sizes are given in table 8.13. It can be noted that in both United Kingdom and Australian practice, the rating criteria are independent of the cable size. An attempt to match or classify the duty of mining machines with the well-defined IEEE categories, however, results in only one conclusion: the typical mining duty is equivalent to a varying-duty classification. Although mining sequences through given events regularly, distances constantly change; hence, equipment utilization changes. In such cases, the IEEE recommends the use of standard application methods to offset the problems of a nonconstant load, and suggests the use of load-factor and rms current calculations. These should be applicable to electrical equipment, such as cables, which are "sufficiently standardized both in performance and construction" (*17*).

Table 8.13.—Intermittent-duty ratings for trailing cables

Cable size, mm [2]	*Approximate* U.S. cable equivalent, AWG	Continuous current rating, A	Intermittent current rating, A	Increase, %
		UNITED KINGDOM [1]		
16	5	85	90	6
25	3	110	120	9
35	2	131	145	11
50	1/0	168	190	13
70	2/0	205	235	15
95	4/0	247	290	18
		AUSTRALIA [2]		
21	4	70	95	36
33	2	90	125	39

[1] Criteria: full-load current for 40 min, no-load current for 10–15 min, 1/2 full-load current for 40 min, no-load current for 10–15 min; ambient at 25°C.
[2] Criteria: full-load current for 30 min, no-load current for 30 min.

Voltage Calculations

The major concern for voltage calculations is that adequate voltage must be at the machine terminals for proper starting and operation. As stated in chapter 6, the allowable voltage tolerance on all rotating machines is ±10% for normal load conditions. Maintaining adequate voltage is one of the more difficult problems in mining, and is often the main constraint on mine expansion from a point of power delivery to the operation.

As mentioned earlier, the voltage drop across trailing cables that have been properly selected by current calculations is usually not a problem because of length constraints in mining. This is especially true in underground coal mining, where the maximum length is restricted by the cable size used (as shown in table 8.6). One problem here, however, is that the maximum practical trailing-cable size that can be used is also constrained by the maximum weight that workers can physically handle. For three-conductor cables, this is considered to be 4/0 AWG, but use of 4/0 AWG can cause voltage-regulation restrictions on high-horsepowered machinery. Trailing-cable voltage drop may also be a concern in surface mines where utilization is at distribution voltage levels.

Using the allowable voltage tolerance as a guide, good practice calls for limiting the maximum voltage drop under normal load conditions to not more than 10% of the nominal system voltage for each voltage level. For surface mines where machines operate at the distribution voltage, this would be equivalent to a maximum voltage drop from the substation secondary to the machines. In underground or surface mines containing power centers or a unit substation, this is not so apparent. Again, the maximum voltage drop must be restrained to 10%, but such a drop

can occur across the trailing cable alone. Consequently, the power-center or unit-substation primary must be maintained as close to its normal voltage rating as practical. To obtain this objective in practice can be a very difficult task, because power centers, for example, are usually at the extreme end of the distribution system. However, most mine power-center transformers are designed with two 2.5% taps above and below the rated primary voltage. Therefore, when voltage taps are available, the maximum allowable voltage drop under normal load conditions in the distribution system (from the substation to the power centers or unit substations) is 10%.

It is interesting to compare the 10% allowance with other electrical applications. For lighting, the NEC recommends 1.0% (2). Industries other than mining consider 2.0% as good-to-excellent regulation and 4.0% as satisfactory.

For a thorough voltage-regulation study of a mine, the impedances of the source, the transformers, and all cables must be known. Tables 8.14 and 8.15 provide typical resistance and 60-Hz reactance values for popular mining cables (5); the missing parameters in these tables imply the cable is not popular or not considered suitable for mining usage. Manufacturer, power-equipment, and utility specifications must be consulted for other information. If cable sizes are not known, an assumption has to be made in order to carry out the calculations. Obviously, the loads on the power system must also be known. A circuit diagram must then be prepared and calculations performed to see if there will be adequate voltage levels at the loads. If calculated voltages are below those tolerated, system impedance must be reduced: the most convenient way is to increase cable sizes. Calculations are again performed to check for the desired result. In other words, the process is basically trial and error. It must be performed for normal load conditions; however, it is also recommended that calculations be made to ensure that critical motors can be started under worst case conditions.

Even with a small system using the per-unit method, the computations can become so involved that accurate hand calculations are extremely time consuming or nearly impossible to obtain. Consequently, load-flow computer programs are the only answer; these are discussed further in chapter 10. However, there are some simple hand-calculation procedures that may be used for initial cable sizing, or for quick verification of voltage conditions in an existing system. These methods will be explored in the next example.

Table 8.14.—Resistance and reactance of portable power cable

Conductor size	R (ac), [1] Ω/Mft		X_L (60 H_z), [2] Ω/Mft					
	75°C	90°C	G–GC G+GC, 2 kV	SHD–GC, 2 kV	SHD–GC, 5 kV	SHD–GC, 8 kV	SHD–GC, 15 kV	SHD–GC, 25 kV
AWG:								
8	0.838	0.878	0.034	—	—	—	—	—
7	.665	.696	.033	—	—	—	—	—
6	.528	.552	.032	0.038	0.043	—	—	—
5	.418	.438	.031	.036	.042	—	—	—
4	.332	.347	.031	.035	.040	0.043	—	—
3	.263	.275	.031	.034	.039	.042	—	—
2	.209	.218	.029	.033	.038	.040	0.044	—
1	.165	.173	[3].030	.033	.036	.039	.042	0.046
1/0	.128	.134	.029	.032	.035	.037	.040	.044
2/0	.102	.107	.029	.031	.034	.036	.039	.043
3/0	.081	.085	.028	.030	.033	.035	.038	.041
4/0	.065	.068	.027	.029	.032	.034	.036	.040
MCM:								
250	.055	.057	.028	.030	.031	.033	.036	.039
300	.046	.048	.027	.029	.031	.032	.035	.038
350	.039	.041	.027	.029	.030	.032	.034	.037
400	.035	.036	.027	.028	.030	.031	.033	.036
500	.028	.029	.026	.028	.029	.030	.032	.035
600	.023	.024	.026	.027	.028	.030	.032	.034
700	.020	.021	.026	.027	.028	.029	.031	.033
800	.018	.019	.025	.026	.028	.029	.030	.033
900	.016	.017	.025	.026	.027	.028	.030	.032
1,000	.014	.015	.025	.026	.027	.028	.030	.032

[1] *Criteria:* a. Sizes 8 to 1 based on tinned copper 94.16% conductivity.
b. Sizes 1/0 AWG and larger based on tinned copper 96.16% conductivity.
c. Resistance increased by increments per ASTM B–172, Note 7 (3), to compensate for stranding factor.
d. Skin effect calculated according to Arnold's Table, National Bureau of Standards Monograph 125 (29).
e. Nominal cross-sectional areas.

[2] Criteria: a. Based on conductor dimensions given for class-H rope-lay conductors in table 2.5 of ICEA S–19–81 (21).
b. Extruded-strand shield thickness, 0.015 in.
c. Insulation thickness according to nominals given in Interim Standard 6 to ICEA S–68–516 (19).
d. Diameter adder of 0.075 in to allow for semiconducting tape and metal-braid shield.

[3] Deviation from normal progression due to changes in insulation.

NOTE.—Dash indicates cable is not made.

Table 8.15.—Resistance and reactance of mine-power-feeder cable

Conductor size	R (ac), [1] Ω/Mft, 90°C	X_L (60 Hz), [2] Ω/Mft		
		MP–GC, 5 kV	MP–GC, 8 kV	MP–GC, 15 kV
AWG:				
6	0.510	0.041	0.044	—
5	.404	.040	.042	—
4	.321	.038	.041	—
3	.254	.037	.039	—
2	.201	.036	.038	0.042
1	.160	.035	.037	.041
1/0	.127	.034	.035	.039
2/0	.101	.033	.034	.038
3/0	.080	.032	.033	.036
4/0	.063	.031	.032	.035
MCM:				
250	.054	.030	.031	.034
300	.045	.029	.031	.034
350	.039	.029	.039	.033
400	.034	.029	.030	.032
500	.027	.028	.029	.031
600	.023	.028	.029	.031
700	.020	.027	.028	.030
800	.017	.027	.028	.030
900	.016	.027	.027	.029
1,000	.014	.026	.027	.029

[1] Criteria: a. Based on bare copper 100% conductivity.
b. Nominal cross-sectional areas.
c. Resistance increased by increments per ASTM B–8, Note 3, to compensate for stranding factor.
d. Skin effect calculated according to Arnold's Table, National Bureau of Standards Monograph 125 (*29*).

[2] Criteria: a. Based on conductor dimensions given for class B concentric stranded conductors in table 2.2 of ICEA S–19–81 (*21*).
b. Extruded strand shield thickness, 0.015 in.
c. Insulation thickness according to nominals given in Interim Standard 5 to ICEA S–68–516 (*19*).
d. Diameter adder of 0.033 in to allow for semiconducting tape and copper-tape shield.

NOTE.—Dash indicates cable is not made.

EXAMPLE 8.4

Distribution cables for a segment of an underground coal mine must be sized. A sketch of the situation is provided in figure 8.14 where the loads are two continuous mining sections. Voltages given are line to line. In-mine measurements and analysis of identical section equipment working in similar conditions have shown an effective current demand of 58 A with 0.8 lagging power factor at the power-center primary, when the continuous miner is cutting and loading. Maximum ambient temperature is 20°C. In a detailed study, the substation transformer impedance must be included. For the sake of demonstration, however, the 7,200-V line-to-line voltage at the substation secondary will be assumed constant. The recommendation for allowable voltage drop is 10% across the distribution system. As the impedances of the feeder and portable cables must be known to make the calculation, a good place to start is to estimate line currents and make an initial cable selection by ampacity. From the given information,

$$I_1 = I_2 = 53 \text{ A}.$$

I_3 is related to I_1 and I_2 but is not necessarily equal to their sum, because of the diversity of mining

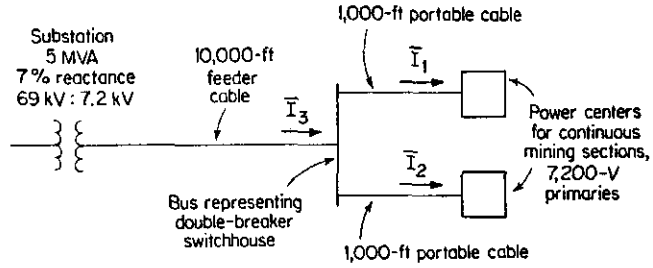


Figure 8.14.—Simplified one-line diagram for situation described in example 8.4.

operations. Chapter 4 presented the concept of demand factor (DF) where using a value from 0.7 to 0.8 is considered reasonable for mining sections: 0.8 corresponding to two sections and 0.7 to four or more sections. Therefore,

$$I_3 = DF(I_1 + I_2) \qquad (8.5)$$

or $$I_3 = (0.8)(53 + 53) = 84.8 \text{ A}.$$

A 7,200-V system requires the use of 8-kV shielded cables, and the corrected ampacity for No. 6 AWG from table 8.7 or 8.8 and table 8.9 is

$$\text{ampacity} = (93)(1.18) = 110 \text{ A}.$$

This means that on a current basis the size is adequate for all distribution cables. Considering the preference of the coal mining industry for using only portable cables for flexibility, ground-check conductors for ground-continuity monitoring, and 90°C insulation, an SHD–GC cable is indicated. Table 8.14 can be consulted for its impedance. It can be seen in the table that No. 4 AWG is the smallest 8-kV SHD–GC portable cable readily available. Hence, a No. 4 AWG will be tried. Its impedance per 1,000 ft is

$$Z_{cable} = 0.347 + j0.043 \ \Omega = 0.35 \angle 7.1° \ \Omega.$$

Referring to figure 8.14, the voltage drop across the distribution line conductors to either power center is (taking the power-center voltage as the reference phasor):

$$V_d = \bar{I}_3 [10(Z_{cable})] + \bar{I}_1 [1(Z_{cable})]$$

$$\bar{V}_d = (84.8\angle -36.9°)(3.5\angle 7.1°) + (53\angle -36.9°)(0.35\angle 7.1°)$$

$$\text{or } \bar{V}_d = 296.8\angle -29.8° + 18.6 \angle -29.8° = 315\angle -29.8° \text{ V}.$$

As per-phase analysis is required to compare this drop with that allowed, the line-to-neutral voltage of the distribution system is used, or

$$V_{1n} = \frac{7{,}200}{\sqrt{3}} = 4{,}160 \text{ V}.$$

The allowable voltage drop is

$$V_d \text{ allowable} = 0.1(4{,}160) = 416 \text{ V}.$$

Therefore, the 315-V drop using No. 4 AWG SHD-GC cables is tolerable. If the voltage drop were not acceptable, an increase in cable size would lower the impedance and the drop.

This simple example had equal cable lengths to the loads, and currents operating at the same phase angle. It should be noted that typical mining systems have many more loads, varying cable length, varying load power factors, and so forth, and the complexity of hand calculations will increase substantially. Per-unit techniques are a tremendous help, but computer analysis is a much more efficient way to solve such problems. Nonetheless, the techniques shown here are useful for partial sizing or spot-checking distribution cables.

Cable Mechanical Strength

The tensile load on the cable should be determined from measurements in the mine, bearing in mind the problems discussed at the beginning of this chapter. The power-conductor breaking-strength data in table 8.16 should then be consulted to assure that the conductor size is large enough to carry the tensile load (*5*). Two things must be considered when using this table. First, grounding and ground-check conductors should not support any of the tensile load, so the overall cable breaking strength should include only the sum of the power-conductor values. Second, the working tension, especially in reeling applications, should not exceed 10% of the breaking strength because copper begins to elongate at that point. Federal regulations acknowledge the problem of exceeding the cable mechanical strength and mandate a minimum trailing-cable size for underground coal mine face equipment: No. 4 AWG for two-conductor dc cables and No. 6 AWG for three-conductor ac cables (*38*).

Table 8.16.—Solid-wire breaking strength

Conductor size, AWG	Hard— 65,000 psi		Medium— 55,000 psi		Soft— 40,000 psi	
	lb	kg	lb	kg	lb	kg
4/0	8,143	3,693.6	6,980	3,166.1	5,983	2,713.8
3/0	6,720	3,048.1	5,666	2,570.1	4,744	2,151.8
2/0	5,519	2,503.4	4,599	2,086.1	3,763	1,706.9
1/0	4,518	2,049.3	3,731	1,692.4	2,985	1,354.0
1	3,688	1,672.8	3,024	1,371.7	2,432	1,103.1
2	3,002	1,361.7	2,450	1,111.3	1,928	874.5
3	2,439	1,106.3	1,984	899.9	1,529	693.5
4	1,970	893.6	1,584	718.5	1,213	550.0
5	1,590	721.2	1,265	573.8	961.5	436.1
6	1,280	580.6	1,010	458.1	762.6	345.9
7	1,030	467.2	806.7	365.9	605.1	274.5
8	826.1	374.7	644.0	292.1	479.8	217.6
9	660.9	299.8	513.9	233.1	380.3	172.5
10	529.3	240.1	410.5	186.2	314.0	142.4
11	423	191.9	327	148.3	249	112.9
12	337	152.9	262	118.8	197	89.4
13	268	121.6	209	94.8	157	71.2
14	214	97.1	167	75.7	124	56.2
15	170	77.1	133	60.3	98.6	44.7
16	135	61.2	106	48.1	78.0	35.4
17	108	49.0	84.9	38.5	62.1	28.2
18	85.5	38.8	67.6	30.7	49.1	22.3
19	68.0	30.8	54.0	24.5	39.0	17.7
20	54.2	24.6	43.2	19.6	31.0	14.1
21	43.2	19.6	34.4	15.6	24.6	11.2
22	34.1	15.5	27.3	12.4	19.4	8.80
23	27.3	12.4	21.9	9.93	15.4	6.99
24	21.7	9.84	17.5	7.94	12.7	5.76
25	17.3	7.85	13.9	6.30	10.1	4.58
26	13.7	6.21	11.1	5.03	7.94	3.60
27	10.9	4.94	8.87	4.02	6.33	2.87
28	8.64	3.92	7.02	3.18	4.99	2.26
29	6.97	3.16	5.68	2.58	4.01	1.82
30	5.47	2.48	4.48	2.03	3.14	1.42

Short-Circuit Currents

The emergency-overload currents that copper conductors can withstand without serious insulation damage are shown in the graph in figure 8.15 (*5*). If the anticipated short-circuit currents are greater than those shown in the graph for the initial selection of conductor size, a larger conductor or a better grade of insulation should be chosen. Chapter 10 covers the calculation methods.

CABLE INSTALLATION AND HANDLING

Cables must be installed and handled correctly in order to minimize damage from tension, bending, twisting, physical wear, cold, heat, and chemical reaction. Cable maintenance costs can be reduced, cable life improved, and safety enhanced by proper installation and handling. In other words, the considerable amount of

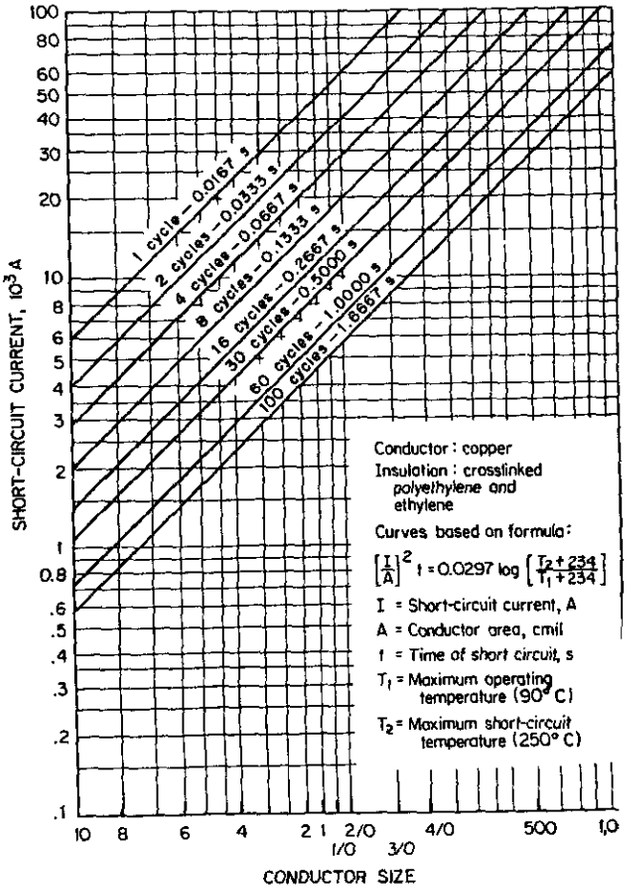


Figure 8.15.—Allowable short-circuit currents for insulated copper conductors.

This specification should be used to define the requirements for a 250 through 1000 HP at 460 Volts variable speed liquid cooled drive.

1.0 GENERAL

A single manufacturer of both motors and drives shall provide, coordinate, and start-up a variable speed drive system to ensure proper application of equipment to the driven load. The variable frequency drive (VFD) and motor shall be manufactured by Rockwell Automation Company Reliance Electric.

A. Motor and VFD shall be of the same manufacturer for single-source responsibility. Factory warranty for a period of at least one year from date of start up or 18 months from date of shipment shall apply for both motor and drive.

B. VFD shall be current rated at 2 kHz carrier frequency for all 250-1000 HP LiquiFlo drives. Drive shall be capable of running at 110% of nameplate current continuously and provide a minimum of 150% of this rated current for 5 seconds.

C. VFD shall not generate damaging voltage pulses at the motor terminals when applied within 500 feet of each other. Both drive and motor shall comply with NEMA MG1 section 30.40.4.2 which specifies these limits at a maximum peak voltage of 1600 Volts and a minimum rise time of .1 microseconds.

D. VFD shall have a liquid-cooled heatsink assembly enabling liquid cooling of the drive through a single inlet and outlet connection point, dissipating 60,000 BTUs/Hr for 1000 HP, 25,000 BTUs/Hr for 400 and 500 HP and 16,000 BTUs/Hr for 350 HP. The cooling circuit must maintain water temperature between 15°C - 40°C. Alternative cooling circuits utilizing R134A shall also be compatible with the drive. Ratings of these units shall be determined by the refrigerant temperature but as a minimum shall be 110% of the above listed water cooling ratings. A nominal 34 PSI pressure drop across the drive heatsink shall be provided by the cooling system for C-frame drives. For B-frame drives, a nominal 6 PSI pressure drop shall be provided. For D-frame drives, 2 nominal 3.5 PSI pressure drop shall be provided.

1.1 CODES/STANDARDS

A. VFD and options shall be UL 508 listed.

B. The drive and options shall be designed to comply with the applicable requirement of the latest standards of ANSI, NEMA, National Electric Code NEC, NEPU-70, IEEE 519-1992, FCC Part 15 Subpart J, CE 96.

C. VFD manufacturer shall be ISO 9001 certified.

1.2 QUALITY ASSURANCE

Each drive shall be subjected to the following test and quality control procedures.

A. Every VFD shall be functionally tested under motor load. During this load test the VFD shall be monitored for correct phase current, phase voltages, and motor speed. Correct current limit operation shall be verified by simulating a motor overload.

B. Verification of proper factory presets by scrolling through all parameters shall be performed to ensure proper microprocessor settings. The computer port should also verify that the proper factory settings are loaded correctly in the drive.

C. Every VFD's heatsink shall be tested to verify proper embedding of the tubing for inflow and outflow of coolant liquid. Thermal tests shall be performed on the VFD to verify the liquid cooling occurs within the temperature range of the coolant liquid.

D. During the design engineering process for the VFD the following quality assurance controls, procedures and tests shall be implemented.

1. Each new product design shall undergo a 4000 hour pre-production burn-in test. Up to 10 units may be used to accumulate this entire time. Each unit shall be temperature cycled between 0°C and 50°C during this time period.

2. Digital integrated circuits shall undergo functional and reliability tests. Regulator circuits must use reliable and compact surface mount construction. These circuits shall be 100% tested on computer-controlled systems. Test equipment must be documented, controlled and calibrated to ISO 9001 standards.
3. Each drive power circuit shall be tested under motor load conditions. While loaded, the output waveform shall be monitored for correct PWM algorithm. Short circuit testing shall be done to UL standards and an AIC rating placed on each controller nameplate.
4. All components utilized with the basic VFD-like contactors, overload relays, pushbuttons, pilot devices, and other control devices shall be UL recognized. These components shall be manufactured by Allen Bradley Company.

1.3 SERVICE

The VFD manufacturer shall maintain and staff world-wide service centers. The manufacturers shall have the ability to test both the drives and motors in these service centers.

A. Start-up shall be included for each VFD provided.

B. Service engineers shall be employed by the manufacturer or be certified by the manufacturer and provide start-up service including physical inspection of drive and connected wiring and final adjustments to meet specified performance requirements.

2.0 DRIVE FUNCTIONS

The VFD shall have the following basic features:

A. An electronic overload circuit designed to protect an AC motor operated by the VFD output from extended overload operation on an inverse time basis. This electronic overload shall be UL and NEC recognized as adequate motor protection. No additional hardware such as motor overload relays or motor thermostats shall be required.

B. An LED display that digitally indicates:

1. Frequency output
2. Voltage output
3. Current output
4. Motor RPM
5. Input kW
6. Elapsed time
7. Time stamped fault indication
8. DC bus volts

C. The VFD shall have the capability of riding though power dips up to 10 seconds without a controller trip depending on load and operating condition. In this extended ride through, the drive shall use the energy generated by the load inertia of the motor fan as a power source for all electronic circuits.

D. RS232 Port and Windows™ based software for Configuration, Control, and Monitoring.

E. An isolated 0-20 mA, 4-20 mA or 0-4, 0-8, 0-10 V analog speed input follower.

F. An isolated 0-10 V or 4-20 mA output signal proportional to speed or load.

G. The VFD shall have the capability of riding though power dips up to 10 seconds without a controller trip depending on load and operating condition. In this extended ride through, the drive shall use the energy generated by the rotating motor as a power source for all electronic circuits.

H. Standard I/O expansion interface card with the following features:

1. PI regulator for set point control
2. Four isolated 24 VDC programmable digital inputs
3. An additional analog input for speed feedback to PI regulator
4. One frequency input (0 to 200 Hz) for digital control of speed or trim reference
5. Four programmable isolated digital outputs (24 VDC rated)
6. One Form A output relay rated at 250 VAC or 24 VDC
7. Two NO/NC programmable output relays rated at 250 VAC or 24 VDC

2.1 PROTECTIVE CIRCUITS AND FEATURES

The VFD shall include the following protective circuits and features:

1. Motor current exceeds 200% of drive continuous current rating.
2. Output phase-to-phase short circuit condition.
3. Total ground fault under any operating condition.
4. High input line voltage.
5. Low input line voltage.
6. Loss of input or output phase.
7. External fault. (This protective circuit shall permit wiring of remote N.C. safety contact to shut down the drive).
8. Metal oxide varistors for surge suppression shall be provided at the VFD input terminals.

2.2 SERVICE CONDITION

The VFD shall be designed and constructed to operate within the following service conditions:

A. Suitable for continuous operation at an ambient temperature of 0°C to 40°C, elevation up to 3300 feet altitude with a relative humidity to 95% non-condensing.

B. AC line variation of -10% to + 10% Voltage and ±5 Hz Frequency.

C. AC line distribution system capacity shall not exceed 85,000 Amps symmetrical available fault current.

2.3 GENERAL OPTIONS AND MODIFICATIONS

The following options shall be included as specified in the document:

A. The panel mount kit shall have the following options:

- A fan for cabinet cooling and associated mounting brackets.
- Three bus bar to cable adapters for connection to user supplied six pulse rectifier input.

- Three bus bar to cable adapters for connection to user supplied motor leads.
- Two 10" hoses for extension from the inlet and the outlets of the liquid-cooled heatsink assembly.
- One sheet metal panel to cover the control boards.

B. Input line fuses shall provide protection for the input rectification circuit using Class J fuses with interrupting rating of 200,000 AIC. The series interrupting rating of the VFD and fuses shall be a minimum of 85,000 AIC and shall be stated in the VFD instruction manual as required by UL. Another option for protection of the input circuit shall be through circuit breakers.

C. A main input disconnect shall mount within the standard NEMA 1 or NEMA 4 enclosure for positive power disconnect of the VFD. It shall have the capability for door padlocking.

D. A 3-phase 3% impedance input line reactor shall be provided to minimize drive harmonics on the AC line and protect the drive from damaging electrical system transients. The 414-643 Amp VFD shall also include the capability for 12-pulse connection using an isolation transformer with a phase shifting secondary.

E. Communication option card shall allow direct connection from the LiquiFlo to the host controller bus architecture. All configuration and control functions can be accessed through this card, allowing direct communication between the LiquiFlo microprocessor and the host system. Fault diagnostics, start/stop, speed commands, and all drive feedbacks shall be available over a single network communication connection.

Networking options shall be available with the above listed functionality to directly connect to:

- Siemens Building Technologies P1-FLN Apogee® Protocol
- Johnson Metasys N2
- DeviceNet
- ControlNet
- Automax
- Modbus
- BACnet
- Profibus
- Interbus-S

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Electrical System

Introduction

The input power to the 14CM15 is three-phase 950 Vac. Traction motors are controlled with a Dual 6SCR drive system. An isolation-type transformer reduces line input voltage to the Dual SCR Drive System which then converts the AC to DC power for the traction motors. A control transformer drops the line voltage to 110 volts AC for the control circuit, and 12 volts for the headlight circuit.

The DC traction motor circuit is protected by a current limiting feature for the traction motor current. This will prevent the traction motor current from continuing to increase if an obstruction is encountered while tramming. If this current limit is reached and the operator continues to tram the machine, thermal overloads will open to protect the traction motors. A cutter motor feedback feature of this control regulates the sump speed of the miner, relative to the resistance of the drums rotating in the mine face. As resistance increases, the current monitoring feature will regulate the DC input voltage to the tram motors, and regulate the available tram speed to the machine. This is an adjustable feature, and can be regulated by the mine personnel to match mining conditions.

Power Requirements

The supply voltage should always be at least 90% of the specified voltage when under load. It should never be more than 110% when not under load. A voltmeter, located on the machine, is calibrated to indicate 100% when the supply voltage is identical to the machine design voltage. Thus, if the voltmeter indicates 90%, the supply voltage is 9/10 of machine design voltage. On a 950 volt machine, the supply voltage would be 9/10 of 950, or approximately 855 volts. A 110% voltmeter reading would indicate a 1,045 volt input.

Component Location

Control hardware for the electrical circuits is housed in three permissible cases:

- The master station houses the machine mounted control switches, the indicator lights and gauges, the control transformer, the Control and Light breaker, and the Main breaker. The trailing cable enters the master station and connects to the main breaker.
- The traction or L.H. controller case contains the traction breaker, power transformer, and the traction motor SCR and overload components.
- The R.H. controller case contains the cutter motor, gathering head motor, pump motor, and dust collector fan motor contactors. The cutter motor circuit breaker is also located in this enclosure.

Motors

The 14CM15 is powered by eight electrical motors.

Motor	No.	Horsepower	Current
Cutter	2	120 (89.5kW) 165 (124 kW) 210 (157 kW) 235 (175 kW)	AC
Pump	1	40 (30 kW)	AC
Gathering Head	2	67 (50 kW)	AC
Exhaust Fan	1	30 (22 kW)	AC
Traction	2	50 (35 kW)	DC

TAB 3

Paul Horn

From: "GREG MCKINNEY"
To: <bechfork@mikrotec.com>
Cc: <jdbridges@worldnet.att.net>
Sent: Thursday, January 10, 2002 2:50 PM
Subject: Load Profile for the new Beech Fork Mine

Mr. Horn,

I need the following information from you regarding your mining operation at Beech Fork for the first 10 years of service:

Annual Peak kW Demand
Annual kWH usage
Power Factor at Peak kW

I realize these load projections may be hard to determine at this point in time. However, they are very critical for the necessary planning studies to be complete.

Please provide me with this information as best as you can and as soon as possible so that we can meet your request for service.

If you have questions, please give me a call or an email.

Sincerely,

Greg McKinney, P.E.
Senior Engineer
Power Delivery Expansion
East Kentucky Power Cooperative
4775 Lexington Road 40391
P.O. Box 707
Winchester, KY 40392-0707
(859) 744-4812

Paul Horn

From: "Paul Horn" <bechfork@mikrotec.com>
To: <gregm@ekpc.com>
Sent: Monday, February 25, 2002 12:45 PM
Attach: Power_Timeline.doc
Subject: Czar Project

Greg,

Hope this help.

Paul

CZAR COAL CORP.
ALAM PROJECT

Timeline
Mining Unit

Start Date _First Six (6) Months	__One (1) Section	1,000 kw / 250,000 kwh per month
	__ Slope Belt	746 kw / 286,460 kwh per month
	__ Hoist	225 kw / 110,000 kwh per month
For First 1 ½ Years	__ Fan	150 kw / 112,000 kwh per month
Total		**2,121 kw / 758,460 kwh per month**

Mining Unit

After First Six (6) Months	__Two (2) Section	2,000 kw / 500,000 kwh per month
After First 1 ½ Years	__ Fan	373 kw / 277,500 kwh per month
Total After 1 ½ Years		**3,344 kw / 1,176,960 kwh per month**

TAB 4

Customer: Beech Fork Processing
Account :

Date: 04/16/03
Billing Mo. April 2003

Tariff: 360 Transmission Rev 3/21/01

contract capacity			3000	kw
High Prev. Billing Demand			3000	KW
Readings (Extension):		K	1203120	KWH
		R		KVARH
	on-pk	D	3000	KW
	off-pk	D	3000	KW
		V	0	KVAR
Environmental Adjustment Factor			2.244500%	
Fuel Adjustment Factor:			0.0004061	
Net Merger Credit			-0.000459	
School Tax		0		***
State sales Tax		0		***

Days: 30 Pro-Rate Factor 1.000

Comments: 138 kv delivery - assuming .557 % load factor - 2 section slope mine
Tariff Code 360

Billing Demand	3000
Billing KVAR	0

Service Charge:						$1,353.00
Demand Charge:	(	$7.88	X	3000	)	$23,640.00
Dem. Ch. Off-pk:	(	$0.85	X	0	)	$0.00
Energy Charge:	(	$0.01155	X	1203120	)	$13,896.04
Reactive Charge	(	$0.57	X	0	)	$0.00
				Subtotal		$38,889.04
		Pro-Rated Subtotal				$38,889.04
Environmental Adjustment						$871.44
Fuel Cost Adjustment						$488.59
Net Merger Credit						($552.23)
Net Bill Amount						$39,696.84
School Tax		0				$0.00
State Sales Tax		0				$0.00
Total Amount Due						$39,696.84

Prepared By: _____

Customer: Beech Fork Processing
Account :

Date: 04/16/03
Billing Mo. April 2003

Tariff:	359	Subtransmission	Rev 3/21/001		
contract capacity			3000	kw	
High Prev. Billing Demand			3000	KW	
Readings (Extension):		K	1203120	KWH	
		R		KVARH	
	on-pk	D	3000	KW	
	off-pk	D	3000	KW	
		V	0	KVAR	
Environmental Adjustment Factor			2.244500%		
Fuel Adjustment Factor:			0.0004061		
Net Merger Credit			-0.000459		***
School Tax		0			***
State sales Tax		0			***
Days:	30	Pro-Rate Factor		1.000	

Comments: 69 kv delivery - 2 section slope mine - assuming load factor of .557 %
Tariff Code 359

Billing Demand	3000
Billing KVAR	0

Service Charge:						$662.00
Demand Charge:	(	$8.51	X	3000	)	$25,530.00
Dem. Ch. Off-pk:	(	$0.86	X	0	)	$0.00
Energy Charge:	(	$0.01171	X	1203120	)	$14,088.54
Reactive Charge	(	$0.57	X	0	)	$0.00
				Subtotal		$40,280.54
		Pro-Rated Subtotal				$40,280.54
Environmental Adjustment						$902.67
Fuel Cost Adjustment						$488.59
Net Merger Credit						($552.23)
Net Bill Amount						$41,119.57
School Tax		0				$0.00
State Sales Tax		0				$0.00
Total Amount Due						$41,119.57

Prepared By: _____